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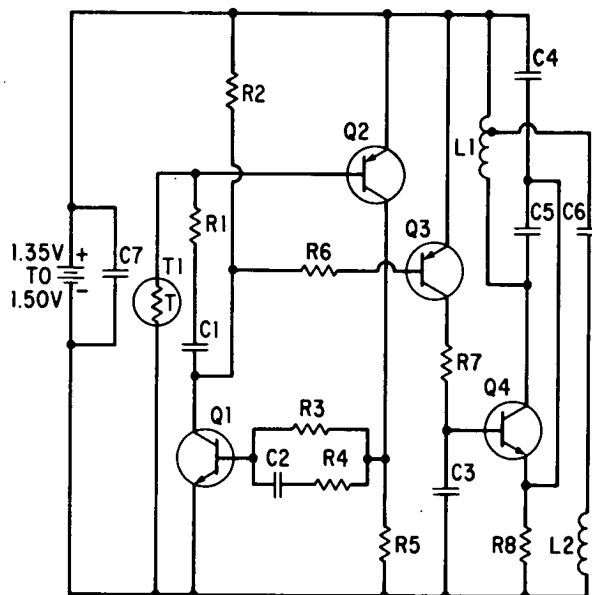
An Ingestible Temperature-Transmitter

Deep body-temperature is an important parameter in studies of circadian rhythm as well as an indicator of general health. In the past, deep body-temperature has been measured by hard-wired thermistor ear-probes that must be fitted to the subject's ear and be in intimate contact with the ear drum; naturally, the subject is in constant discomfort.

Small, ingestible temperature-transmitters cause no discomfort. The ingestible transmitters that were first developed were primarily blocking-oscillator telemetry devices using a single transistor as the active element; these devices are simple, but their long-term stability is rather poor and their transmission distances are quite limited. More complicated, stable, and highly accurate transmitters were later developed for long-term implant; however, these units have not been considered suitable for use because they are expensive and too large and complex. A pill-sized ingestible temperature-transmitter has now been developed that is a compromise between accuracy, circuit complexity, size, and transmission range.

The circuit of the pill transmitter consists of a complementary astable multivibrator comprised of Q1 and Q2; the on-off cycle of each transistor is controlled by a fixed resistor and a thermistor. A buffer transistor, Q3, decreases the amount of frequency modulation of the radiofrequency transistor, Q4. The tuned section of the transmitter consists of L1, C4, and C5; inductor L1 is tapped to provide appropriate impedance-matching for the RF-radiation element, L2, driven through DC-decoupling capacitor, C6. The transmitter operates in the 88- and 108-MHz band in order to take advantage of readily available commercial FM receivers.

The complete miniature unit, consisting of an RM-212 battery and a transmitter circuit, is placed in a size 0 gelatin capsule and then sealed with vinyl acetate-beeswax mixture and two coats of silicone



rubber. Completed units are tested by immersion for 35 hours in a hydrochloric acid solution of pH 1 at 45°C to insure the integrity of the coatings which prevent the gelatin capsule from dissolving.

Nominal current drain from the battery at body temperature is 25 microamperes, and the operating life of the encapsulated device is approximately 600 hours. A unique feature of the device is that power consumption can be reduced to a negligible value by storage at approximately 0°C, thereby extending the

(continued overleaf)

storage time indefinitely. The transmitter does not require critical-tolerance parts and after calibration it provides temperature measurements well within $\pm 0.1^{\circ}\text{C}$ from 35° to 41°C .

Note:

Requests for additional information may be directed to:

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Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to:

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